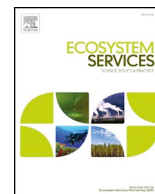




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Critical warning! Preventing the multidimensional apocalypse on planet Earth

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ABSTRACT

Intensified human activities are causing ever-growing threats to biodiversity, including humans and ecosystem services. Conversely, evidence showing the multiple benefits and socio-economic values of ecosystem services and goods is increasing substantially. A fundamental societal revolution is urgently needed to preserve the health of populations of living beings, communities and ecosystems. The present article aims to convey that the multidimensional (sanitary, social, economic, political, ecological and ideological) crisis we are facing should force us to build bridges and exchanges between science, the public and politics — an essential prerequisite to implement coherent and sustainable biodiversity, public health and education policies on both local and global scales.

The intensification of human activities is responsible for the unprecedented destruction of natural habitats and their (human and non-human) populations on Earth. The causes of destruction include, in particular, individualism, speciesism, short-termism and the development of uncontrolled economic liberalism promoting intensive agriculture, mining, fishing and urban expansion models. These causes 1) lead to deforestation, 2) pollute the soil as well as the air and the water that we consume daily, 3) deplete a wide range of natural resources and ecosystem services, 4) promote closer contact with wildlife and exposure to new pathogenic parasites (e.g. viruses and bacteria) and 5) contribute to global warming, only to mention a few of the consequences.

With regard to human populations, these causes of destruction have devastating health, socio-economic and ecological consequences. For example, numerous studies report a significant negative impact of air pollution (inside and outside homes) on human health, increasing the incidence and progression of diseases such as allergies, asthma, lung cancer, Alzheimer's and Parkinson's diseases, psychological complications, autism, abnormal fetal growth, and low birth weight (e.g. Dockery et al., 1993; Zhang and Smith, 2003; Di et al., 2017; Lelieveld et al., 2019). Recently, Lelieveld et al. (2019) showed that air pollution kills almost 800,000 people a year in Europe. In comparison, the First World War killed nearly 9.5 million soldiers between 1914 and 1918 (e.g. Audoin-Rouzeau and Becker, 2004). In 12 years, the air pollution

we create thus kills as many people as the First World War in Europe! Exposure to zoonotic diseases (i.e. diseases that are passed from animals to humans) also has a considerable impact on human health since it causes around 60% of the emerging infectious human diseases, the majority of these (72%) originate in wildlife such as HIV/AIDS, Ebola, Lyme disease and coronaviruses (e.g. Woolhouse and Gowtage-Sequeria, 2005; Jones et al., 2008). For example, HIV/AIDS killed almost one million (954,000) people worldwide in 2017 (Roth et al., 2018). SARS-CoV-2, responsible for the current COVID-19 pandemic, contaminated 4,766,468 people and killed 318,200 people worldwide, between 31 December, 2019 and 19 May, 2020, that is to say in only about five and a half months (The European Centre for Disease Prevention and Control, 2020).

On the socio-economic front, environmental pollution, degradation and destruction incur an exorbitant cost due to the gradual loss of biodiversity in ecosystems. Conversely, a very large and growing body of evidence clearly shows the multiple benefits and socio-economic values of ecosystem services and goods (e.g. Costanza et al., 1997; De Groot et al., 2012; Harrison et al., 2014; Luederitz et al., 2015; Tebboth et al., 2020; Fish et al., 2016; Maes et al., 2016; Costanza et al., 2017; Costanza, 2020). Biodiversity promotes health and a number of benefits to humans, from psychological, social-cultural, cognitive, and physiological benefits to reduced incidence of infectious diseases, increased resilience and tangible materials such as food supplies, raw materials

Abbreviations: HIV, Human Immunodeficiency Virus; AIDS, Acquired Immunodeficiency Syndrome (i.e. the final stage of infection with HIV); SARS-CoV-2, Severe Acute Respiratory Syndrome CoronaVirus 2; COVID-19, CoronaVirus Infectious Disease 2019

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and medicines (e.g. Sandifer et al., 2015; Cooper et al., 2016). For example, the potential ecosystem services to society of an “average” hectare of coastal wetlands (e.g. tidal marsh and mangroves) and coral reefs are estimated at US\$ 195,000/year and US\$ 350,000/year, respectively (De Groot et al., 2012). Specifically, mangrove forests (Saenger et al., 1983) have tremendous values that are generally classified in three broad categories: 1) direct (consumptive and non-consumptive) use values related to physical interactions with mangroves and their services, including wood and non-wood products (e.g. timber, fiber, fuel wood, charcoal, food, medicine, genetic materials) as well as educational, recreational and cultural uses; 2) indirect use values include regulatory ecological functions such as flood, storm and erosion control, prevention of salt water intrusion, air pollution reduction and carbon storage; 3) non-use values include existence and heritage values of mangroves such as biodiversity and culture (e.g., United Nations Environment Programme, Nairobi, 2006; TEEB, 2010). Brander et al. (2012) provided an estimate of the value of foregone ecosystem services from mangroves in Southeast Asia under a baseline scenario for the period 2000–2050. The estimated foregone annual benefits in 2050 are US\$ 2.2 billion, with a prediction interval of US\$ 1.6–2.8 billion. Emerging infectious diseases also have serious economic consequences for public finances, businesses and workers. Researchers recently estimated the expected annual cost for the world of an influenza pandemic at US \$ 490 billion (0.6 % of global income), including both lost income and the intrinsic cost of elevated mortality; they estimated the expected annual number of influenza-pandemic-related deaths at about 720,000 (Fan et al., 2018).

On the ecological front, scientists are unequivocal: the sixth mass extinction of animal and plant species has already started (e.g. Ceballos et al., 2010, 2017; Pimm and Joppa, 2015). For example, in 2002, 173 species of mammals covering six continents had already lost more than 50% of their populations (Ceballos and Ehrlich, 2002). Regarding our close cousins, the non-human primates, 60% of the 504 species are in danger of extinction and 75% of their populations are in decline (Estrada et al., 2017). Between 1999 and 2015, almost half the population of Borneo orangutans (*Pongo pygmaeus*) – over 100,000 individuals – was decimated due to the destruction of their natural habitat (Voigt et al., 2018). The survival of the human species depends on the balance of animal, plant and bacteria biodiversity (e.g. Bell et al., 1997; Morand and Lajaunie, 2017), yet millions of animal, plant and bacteria species are threatened with extinction during the coming decades (Díaz et al., 2019).

The goal of this article was to convey a clear, concise and convincing message emphasizing the strong interdependence of humans and biodiversity-ecosystem services on both local and global scales, and this in turn helps us to understand better the complex intertwinement between the sanitary, social, economic, political, ecological and ideological dimensions of the current crisis. This awareness-raising message can thus serve as a basis for effective communication between the scientific, public and political spheres. The current multidimensional crisis is shaping Earth's ecosystems and human societies and will undoubtedly trigger new and unfamiliar problems such as those we have recently experienced with the COVID-19 pandemic. Therefore, tackling this crisis effectively requires a collective and coordinated approach on both local and global scales that not only addresses the consequences of this crisis, but also its causes. Solutions are challenging but feasible if the individual and political wills are there. For instance, we need 1) to promote and develop significantly agroecological farming and eco-friendly energy, urbanism and transportation, 2) to foster substantially sustainable consumption of food, water, goods and services as well as waste recycling, 3) to promote and nurture social cohesion, cooperation and coordination within and among groups, communities and countries and 4) to cultivate human services to all types of ecosystems (not only natural protected areas but also other areas such as gardens, parks and urban forests) by protecting, conserving and restoring them meaningfully. These are important and promising solutions, but what is even

more important is to make them real in our everyday life from now on. Furthermore, it is also crucial that we combine the forces and ideas from multiple disciplines to implement responsible biodiversity, public health and education policies in the short and long term. The future of our species and of many others depends on this.

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